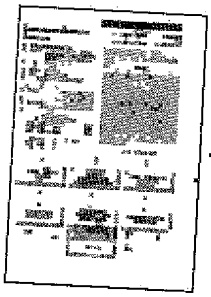
The Delphion Integrated View

Title: **JP08138876A2: COLD-CATHODE TUBE LIGHTING APPARATUS USING PIEZOELECTRIC TRANSFORMER**

Derwent Title: Cold cathode tube lighting device using piezoelectric transformer and inverter appts. - has chopper circuit which performs boosting of input voltage that is fed to series resistance circuit connected to primary of transformer [Derwent Record]

Country: **JP** Japan

Kind: **A**



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Abstract: PURPOSE: To solve some troubles of an inverter apparatus attributed to a wire-wound transformer by using a piezoelectric transformer and provide a cold-cathode tube drive apparatus for which the piezoelectric transformer is used and which can carry out lighting of a cold-cathode tube and modulating the light.
CONSTITUTION: An inverter apparatus is an apparatus having a cold-cathode tube CFL1 and a lighting circuit to light the cold-cathode tube and for which a piezoelectric transformer T1 is used and a voltage booster chopper is installed in the prior stage to a semi-E-class voltage resonance inverter for the purpose to complement the voltage boosting rate of the piezoelectric transformer, the inverter and a power switch element of a chopper are composed of the same power switch element Q1, and the cold-cathode tube is controlled at constant current by a single voltage resonance control ICIC1. Since a lighting circuit is composed by using the piezoelectric transformer, the number of part items can be lessened and the apparatus can be miniaturized and at the same time the manufacturing cost is lowered. Furthermore, the lighting frequency of a discharge lamp can be heightened by increasing the resonance frequency of the piezoelectric transformer and consequently discharge efficiency can be improved.
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INPADOC Legal Status: None **Buy Now:** Family Legal Status Report

Family:

Buy PDF	Publication	Pub. Date	Filed	Title

	US5834907	1998-11-10	1995-11-14	Cold cathode tube operating apparatus with piezoelectric transformer
	JP08138876A2	1996-05-31	1994-11-16	COLD-CATHODE TUBE LIGHTING APPARATUS USING PIEZOELECTRIC TRANSFORMER
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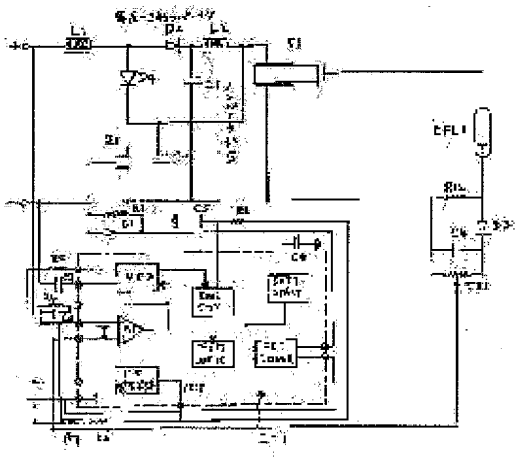
(72)Inventor : TAKEHARA TAKAO

(54) COLD-CATHODE TUBE LIGHTING APPARATUS USING PIEZOELECTRIC TRANSFORMER

(57)Abstract:

PURPOSE: To solve some troubles of an inverter apparatus attributed to a wire-wound transformer by using a piezoelectric transformer and provide a cold-cathode tube drive apparatus for which the piezoelectric transformer is used and which can carry out lighting of a cold-cathode tube and modulating the light.



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constant current by a single voltage resonance control ICIC1. Since a lighting circuit is composed by using the piezoelectric transformer, the number of part items can be lessened and the apparatus can be miniaturized and at the same time the manufacturing cost is lowered. Furthermore, the lighting frequency of a discharge lamp can be heightened by increasing the resonance frequency of the piezoelectric transformer and consequently discharge efficiency can be improved.

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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] In the cold cathode tube lighting device which has the piezo-electric circuit which makes a cold cathode tube and this cold cathode tube turn on A series resonant circuit is formed in the upstream of a piezoelectric transformer. The chopper circuit which carries out the pressure up of the input voltage by actuation of the above-mentioned switching element, and supplies a power source to the above-mentioned resonance circuit while establishing the control means of operation which turns this series resonant circuit on and off to the timing to which the phase progressed from the resonance frequency of this resonance circuit by the switching element is prepared. And the cold cathode tube lighting device which used the piezoelectric transformer characterized by connecting a cold cathode tube to secondary [of the above-mentioned pressure-up transformer].
[Claim 2] The cold cathode tube lighting device which used the piezoelectric transformer according to claim 1 characterized by obtaining a return signal from the current of a cold cathode tube, and having the feedback circuit which sets up the switching conditions of said switching circuit.
[Claim 3] The cold cathode tube lighting device which used the piezoelectric transformer according to claim 1 characterized by preparing the soft start circuit in which the switching frequency of an inverter is gradually reduced from a frequency higher than the resonance frequency of a piezoelectric transformer for the above-mentioned control means of operation.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention is used for the power source which uses as a load the cold cathode tube whose light can be modulated especially freely about inverter equipment suitable as a power source of the load which needs current control in the large range, and relates to suitable inverter equipment.
[0002]
[Description of the Prior Art] Inverter equipment is equipment which changes direct current power into alternating current power, and is used for various electrical machinery and apparatus as the so-called power inverter. Drawing 7 is the circuit diagram showing the conventional inverter equipment currently used as an object for the discharge tubes. In drawing 7 , T10 is the pressure-up transformer equipped with primary-coil 10P, secondary-coil 10S, and feedback coil 10F for ROIYA oscillator circuits. TR11 and TR12 constitute a ROIYA-oscillator circuit from a transistor for switching actuation of an NPN mold with the pressure-up transformer T10. The capacitor for voltage resonance in C13 and L14 are these choke coils. Thereby, the collector to emitter voltage at the time of OFF of transistors TR11 and TR12 becomes sine wave-like, and the voltage waveform of primary-coil 10P of a transformer T10 and secondary-coil 10S serves as a sine wave. A choke coil L14 is connected to the DC-DC converter described later, and the cold cathode tube CFL31 is connected to the output side. By this inverter self-oscillation, in an output side, the sine wave-like high voltage appears on the frequency of dozens of kHz unit, and a cold cathode tube CFL31 lights up. IC20 is an integrated circuit (IC) which controls the base circuit of the PNP mold transistor TR21 for switching actuation which constitutes a DC-DC converter, and operates as a pressure-lowering mold chopper circuit. It has the output transistor 113 which drives this IC with the PWM comparator COMP which compares with the output voltage of Transmitter OSC, an operational amplifier A1, or either of A2 Oscillator OSC and two operational amplifiers A1 for a comparison which generate a triangular wave, and the operation magnification A2, and this PWM comparator, and drives the base of PNP transistor TR21 for said switching actuation. Although two operational amplifiers A1 and A2 are connected to the PWM comparator input circuit of another side [like PWM as mentioned above / comparator / PWM / Transmitter OSC / IC / this], an electrical potential difference with the higher output voltage of these two operational amplifiers and the output of Oscillator OSC are measured. In addition, even if it defines IC which has the aforementioned configuration as IC for DC-DC converter control here and uses this for other applications, it will be referred to as IC for DC-DC converter control unless an internal configuration changes. D22 is a fly wheel diode and L23 is a choke coil. C24 is a capacitor and constitutes an LC filter from a choke coil L23 and a capacitor C24. The capacitor for oscillation frequency decision in C25 and R26, resistance, C27, or 30 is C for phase corrections of the operational amplifiers A1 and A2 of IC20 for DC-DC converter control, and R elements. Diodes D15 and D16 are for rectifying the forward component of the discharge current which flows to a cold cathode tube CFL31. R18 and C19 are the resistance and the capacitors which constitute the low pass filter for direct-current-izing a current wave form. This filter

output is connected to the 10 input edge of the operational amplifier A2 of IC20 for DC-DC converter control. That is, in the both ends of a capacitor C19, the electrical potential difference proportional to the forward cycle average value of the discharge current is obtained, this electrical potential difference and the reference voltage of the IC20 interior for DC-DC converter control are compared by the operational amplifier A2, and the output voltage proportional to both difference electrical potential difference is obtained. As shown in drawing 8 , this output voltage and the triangular wave output of the transmitter OSC of IC20 for DC-DC converter control are compared by the PWM comparator. That is, if the discharge current increases by a certain cause, the output voltage of the operational amplifier A2 used as an Error light will shift to an A line from B lines. Consequently, the output of a PMW comparator changes from C Rhine to D Rhine. That is, since the ON time amount of the PNP mold transistor TR21 for switching operation which is an output transistor becomes narrow, the output voltage of a DC-DC converter will decrease and the power circuit of a ROIYA oscillator circuit will fall, the discharge current decreases. Therefore, constant current control of the discharge current is made possible. R32 and R33 are resistance for carrying out the constant voltage of the output voltage of a DC-DC converter, and this is resistance for the DC-DC converter output voltage detection for constant-voltage-izing the electrical potential difference of secondary-coil 10S of the pressure-up transformer T10 before starting discharge, when not connecting a cold cathode tube CFL31. It connected with the 10 input edge of the operational amplifier A1 of IC20 for DC-DC converter control, and the node of resistance R32 and R33 constituted the negative feedback loop formation, and has constant-voltage-ized output voltage of a DC-DC converter. Since OR connection of the output of operational amplifiers A1 and A2 is made, priority is given to the one where the output voltage of operational amplifiers A1 and A2 is higher, and it is inputted into an PWM comparator.

[0003] The high voltage required in order to make a cold cathode tube turn on like 1000-1500V rolls secondary [of a pressure-up transformer] thousands times, and is carrying out the pressure up of the electrical potential difference of 5-19V. The about 40-micron thin line is used for this coil. Thus, when the coil transformer around which many thin lines were coiled is used, problems, such as an open circuit and rare short-circuit, occur, and many man days are needed. Moreover, when a coil transformer is used for the personal computer of the notebook type of which a thin shape is required etc., a structural limitation is to miniaturize. As a remedy of this problem, the method which substitutes the electrical-potential-difference transformer of a ceramic plate for a coil transformer is examined.

[0004]

[Problem(s) to be Solved by the Invention] However, the cure of increasing making board thickness thin in order to raise the pressure-up ratio of a piezoelectric transformer, and a crosswise dimension is needed. However, if board thickness is made thin, while capacity of a drive part can be enlarged compared with the capacity of a generation-of-electrical-energy part, an output impedance becomes high and there is a fault that ****** stopped for the load of output voltage increases. Since the value of K31 and K33 will begin to fall on the other hand if a configuration dependency is in electromechanical coupling coefficients K31 and K33 and the value of width of face/die length becomes 0.3 or more although an output in SUPI dance can be reduced when the measures which increase the width method are taken, width of face cannot be recklessly made large, but if width of face is increased to some extent above, a pressure-up ratio will decrease rather. Therefore, when a miniaturization is considered, there is a limitation in a pressure-up ratio. Moreover, although carrying out a pressure up by the coil transformer, and driving a piezoelectric transformer is performed in order to obtain sufficient pressure-up ratio, there is a problem of causing an equipment cost rise and enlargement.

[0005] This invention is made in view of such a point, and it aims at offering the driving gear of the cold cathode tube using the piezoelectric transformer which solves many problems of the inverter equipment resulting from a coil transformer by using a piezoelectric transformer, unites them, and can perform lighting and modulated light of a cold cathode tube.

[0006]

[Means for Solving the Problem] In order to attain the purpose of above-mentioned this invention, this invention In the cold cathode tube lighting device which has the piezo-electric circuit which makes a

cold cathode tube and this cold cathode tube turn on A series resonant circuit is formed in the upstream of a piezoelectric transformer. The chopper circuit which carries out the pressure up of the input voltage by actuation of the above-mentioned switching element, and supplies a power source to the above-mentioned resonance circuit while establishing the control means of operation which turns this series resonant circuit on and off to the timing to which the phase progressed from the resonance frequency of this resonance circuit by the switching element is prepared. And the cold cathode tube lighting device which used the piezoelectric transformer characterized by connecting a cold cathode tube to secondary [of the above-mentioned pressure-up transformer] is offered. Furthermore, obtain a return signal from the current of a cold cathode tube, and the feedback circuit which sets up the switching conditions of said switching circuit is added to the above-mentioned cold cathode tube lighting device. The cold cathode tube lighting device which used the piezoelectric transformer which furthermore added the soft start circuit in which the switching frequency of an inverter is gradually reduced from a frequency higher than the resonance frequency of a piezoelectric transformer to the control means of the above-mentioned cold cathode tube lighting device of operation is offered.

[0007]

[Function] A manufacturing cost is low-**(ed) while components mark can constitute equipment small few according to the cold cathode tube lighting device which used the piezoelectric transformer concerning this invention, since the lighting circuit is constituted using an electrical-potential-difference transformer. Moreover, by making resonance frequency of a piezoelectric transformer high, the lighting frequency of a electric-discharge lamp can also be made high, and, thereby, becomes good [discharge effectiveness].

[0008]

[Example] Next, one example of this invention is explained to a detail using a drawing. Drawing 1 is the circuit diagram of one example of the cold cathode tube lighting device which used the piezoelectric transformer concerning this invention. Although the light of a cold cathode tube was modulated in the conventional example shown in drawing 7 by carrying out adjustable [of the supply voltage of a ROIYA oscillator circuit, i.e., the output voltage of a DC-DC converter,] according to the value of the discharge current In this invention, while connecting semi- Class E voltage resonance mold inverter with a pressure-up mold chopper at the output and driving CFL1 directly using the same power switching device, the circuit which drives a power switching device carries out negative feedback of the current which flows to CFL1, and optimal modulated light is performed.

[0009] Both the current which flows on a power switch, and the electrical potential difference concerning a switch become a part of sine wave, and semi- Class E voltage resonance inverter is known as an inverter in which a sinusoidal output is possible. The principle of operation is explained briefly below. The basic circuit of semi- Class E voltage resonance inverter is shown in drawing 2 . In drawing 2 , Reactor L is a choke coil and the current turns into direct current Ic in approximation. Inductor LT Capacitor CT A resonance circuit is constituted. A pulse-like electrical potential difference is applied to an RLC tuning circuit by ON / off actuation of a switch. If a little higher than the resonance frequency of switching frequency Lt-Ct, the current which flows R-Lt-Ct by the tuning circuit serves as a sine wave in approximation. In this case, the current it which a R-L-C tuning circuit has inductive reactance, and flows to a tuning circuit is the electrical potential difference VS concerning a tuning circuit, i.e., the electrical potential difference of a switch. A phase is late for a fundamental wave. The part which lengthened sinusoidal current It from a direct current Ic here since it was Ic=Isdc+It is Switch S, Diode DS, and Capacitor CS. It is set to Isdc which flows to a parallel circuit, and this also becomes sine wave-like.

[0010] The wave type of Class E resonance inverter in case the duty of a switch is 50% of operation is shown in (a) of drawing 3 . If the turn-off of the switch S is carried out, the current of a sine wave will flow Capacitor CS, and it is Capacitor CS. It flows and is Capacitor CS. It charges and is an electrical potential difference VS. It goes up from zero to a sine wave. Therefore, the turn-off of a switch serves as a zero electrical potential difference and non-zero current switching. As the optimal load Ropt shows to (a) of drawing 3 , it is the electrical potential difference VS of a switch. When it descends to zero by the

inclination dVS near zero / dt and is set to VS =0 and dVS/dt=0, the turn-on of the switch S is carried out. When load resistance is smaller than the optimal resistance Ropt, as it is shown in (b) of drawing 3 , it is the electrical potential difference VS of a switch. It is clamped by the zero electrical potential difference and the turn-on of the switch S is carried out in the meantime. This is semi- Class E actuation, is the same as that of a voltage resonance switch, and serves as zero electrical-potential-difference switching. When making it operate as a switching regulator, a load and the whole adjustable range of input voltage can be covered, Class E cannot be operated, and it becomes semi- Class E actuation. Since the impedance of a R-L-C tuning circuit is sensitive to a switching frequency, when output voltage VO (= It) is controlled by switching frequency modulation, it has the advantage that there is little change of a switching frequency.

[0011] In one example of this invention shown in drawing 1 , T1 is a piezoelectric transformer. The equal circuit of a piezoelectric transformer is shown in drawing 4 . For an input capacitance and C20, an output capacitance and LE are [C10] an equivalence inductance and CE here. Equivalent capacity and RE A transformation ratio and RL of equivalent resistance and n are load resistance. Furthermore, it simplifies and is LE. CE If it converts into a secondary on the conditions which are resonating, it will become like drawing 5 .

[0012] Returning to explanation of drawing 1 , Q1 is the power metal-oxide semiconductor field effect transistor of N channel. L2 is a choke coil. The equivalence inductance LE and equivalent capacity CE of a piezoelectric transformer T1 constitute a resonance circuit, and CFL1 is connected to the resonance circuit and serial. The resonance frequency of a resonance circuit is [Equation 1].

$$Fr = 1 / 2\pi\sqrt{LE \cdot CE}$$

[0013] It becomes. The electrical potential difference between DOREINSO-SU at the time of OFF of a choke coil L2 and a capacitor C 7Q1 becomes sine wave-like. C7 is a capacitor for voltage resonance. On the other hand, a boost chopper-circuit is constituted by a choke coil L1, power metal-oxide semiconductor field effect transistor (Q1) and diode D2, diode D4, and the capacitor C1, and the output voltage by which the pressure up was carried out turns into input voltage of semi- Class E voltage resonance mold inverter. Power metal-oxide semiconductor field effect transistor (Q1) is a power switch common to a boost chopper and semi- Class E voltage resonance mold inverter. IC1 is IC for voltage resonance mold switching which controls the gate circuit of power metal-oxide semiconductor field effect transistor (Q1). This IC is a gate drive circuit (FETDRIVER) which drives by the voltage controlled oscillator (VCO), the operational amplifier A1, and the switching frequency modulation circuit (PFMLOGIC), and drives the gate of power metal-oxide semiconductor field effect transistor (Q1). It becomes. R4 and C2 are the objects for the phase corrections of the operational amplifier A1 of IC1. R5 and C3 are the C-R elements for the oscillation frequency decision of VCO of IC1. R6 and R7 are resistance for the DC biases of the minus input edge of the operational amplifier A1 of IC1. R1 is the Gaea northern sea lion live resistance of power metal-oxide semiconductor field effect transistor (Q1). D1 is the speedup diode for gate stored charge drawing. A lamp current is detected by resistance R12, the forward cycle of a lamp current is detected by diode D3 and the capacitor C4, and it is direct-current-ized. The output is inputted into the plus input edge of the operational amplifier A1 of IC1 through the variable resistance VR 1 for a lamp current setup, and resistance R8. That is, the electrical potential difference proportional to the average of the forward cycle of the discharge current is obtained by the center tap of variable resistance VR 1. It connects with the input edge of a voltage controlled oscillator VCO, and this output voltage controls the oscillation frequency of a voltage controlled oscillator VCO. That is, if the discharge current increases by a certain cause, the output of an operational amplifier A1 will rise and the oscillation frequency of a voltage controlled oscillator VCO will rise. A monostable multivibrator (ONESHOT) is set in falling of the output of a voltage controlled oscillator VCO, and the output becomes high-level. Resistance R2 and capacitor C5 (ONESHOT) An output is time amount (ONESHOT) which becomes settled with the time constant in the object for pulse width decision. An output is kept high-level. The wave of each part is shown in drawing 6 . Toff A choke coil L and voltage resonance mold capacitor CS etc. -- in consideration of fluctuation of the resonance frequency by

dispersion or the temperature change, it sets up so that semi- Class E actuation may be satisfied. Namely, Toff Since an oscillation frequency rises while it has been fixed, the current which the ON time amount of a switch decreases and is supplied to CFL1 as a result decreases, and constant current control is maintained. If a lamp current decreases, the output of an operational amplifier A1 will decline, the oscillation frequency of a voltage controlled oscillator VCO becomes low, and constant current control is performed. C6 is a capacitor which sets up the time delay of a soft start circuit. It descends gradually as the oscillation frequency of VCO will turn into a frequency higher than the time of stationary actuation and a capacitor C6 will be charged, if an electrical potential difference is turned on.

[0014] CFL1 needs to impress the high voltage (usually 1 K-1.5 kV) to starting discharge. This is called open circuit voltage. Since the internal resistance of CFL1 is very large at the time of an astigmatism LGT, when CFL1 becomes [the oscillation frequency of the voltage controlled oscillator VCO of IC1] equal to the resonance frequency Fr of a piezoelectric transformer, the high voltage occurs in the output terminal C of a piezoelectric transformer T1, and CFL1 is turned on. The internal impedance of CFL1 decreases rapidly by this lighting. In order that a piezoelectric transformer T1 may show a constant current characteristic with the internal resistance R, the output of a piezoelectric transformer T1 decreases. In the method which used the coil conventionally with this property, the required ballast capacitor is omissible. That is, CFL1 is turned on, when the power source turned on and the switching frequency of IC1 becomes equal to the resonance frequency Fr of a piezoelectric transformer T1 by the soft start circuit of IC1. Moreover, the pressure-up ratio n of a piezoelectric transformer T1 is n, when thickness of a piezoelectric transformer is set to d and it sets die length to L. It is the reason mentioned above although it became L/d, and a limitation is ** in n. Moreover, the battery voltage of a notebook computer etc. tends to fall increasingly, and the pressure-up ratio of a piezoelectric transformer T1 cannot but become large. It means raising the pressure-up ratio n of a piezoelectric transformer T1 in this invention equivalent by preparing boost chopper - in the preceding paragraph of semi- Class E voltage resonance mold inverter, and raising the input voltage of an inverter.

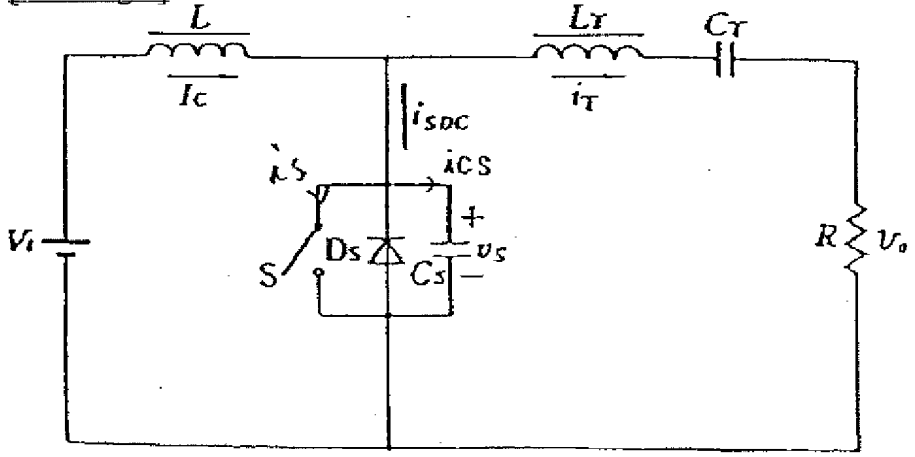
[0015]

[Effect of the Invention] As mentioned above, as explained to the detail, by forming a boost chopper in the preceding paragraph of semi- Class E voltage resonance mold inverter in order to compensate the pressure-up ratio of a piezoelectric transformer, and carrying out constant current control of the cold cathode tube using the single voltage resonance mold control IC using the same power switching device, components mark are decreased more sharply than the conventional thing, and an efficient inverter circuit can be offered at low cost. Moreover, by making resonance frequency of a piezoelectric transformer high, the lighting frequency of a electric-discharge lamp can also be made high, and, thereby, becomes good [discharge effectiveness].

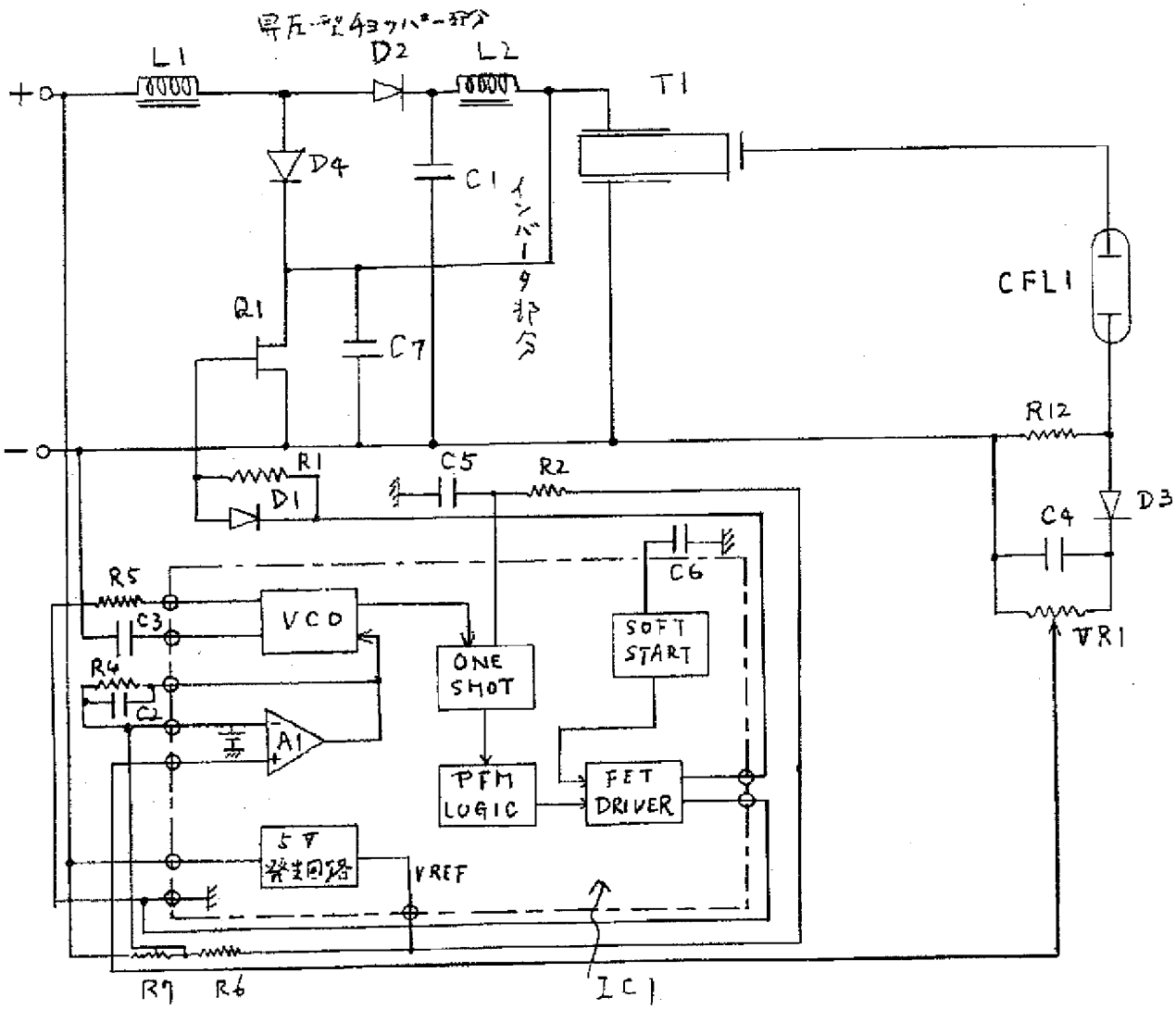
[Translation done.]

DRAWINGS

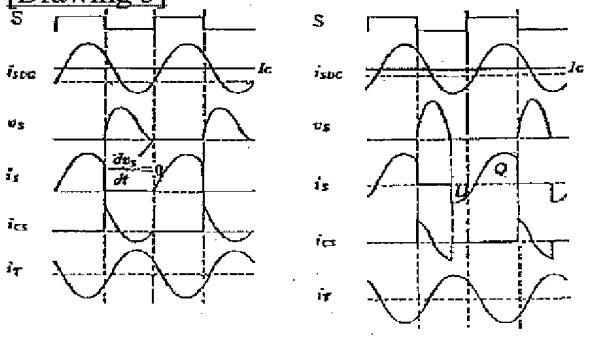
[Drawing 2]



[Drawing 1]



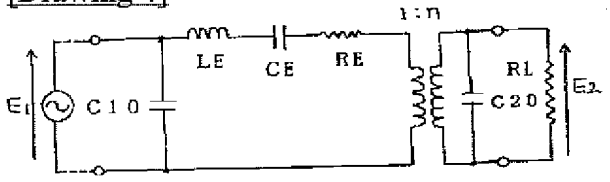
[Drawing 3]



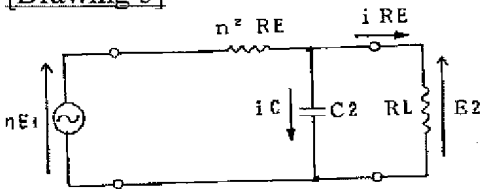
E級共振形インバータの動作波形

注：Sはスイッチドライブ入力

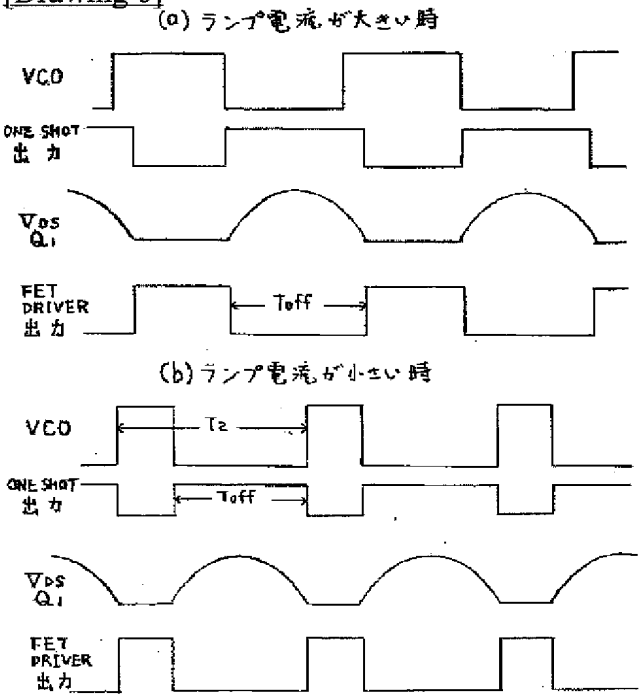
[Drawing 4]



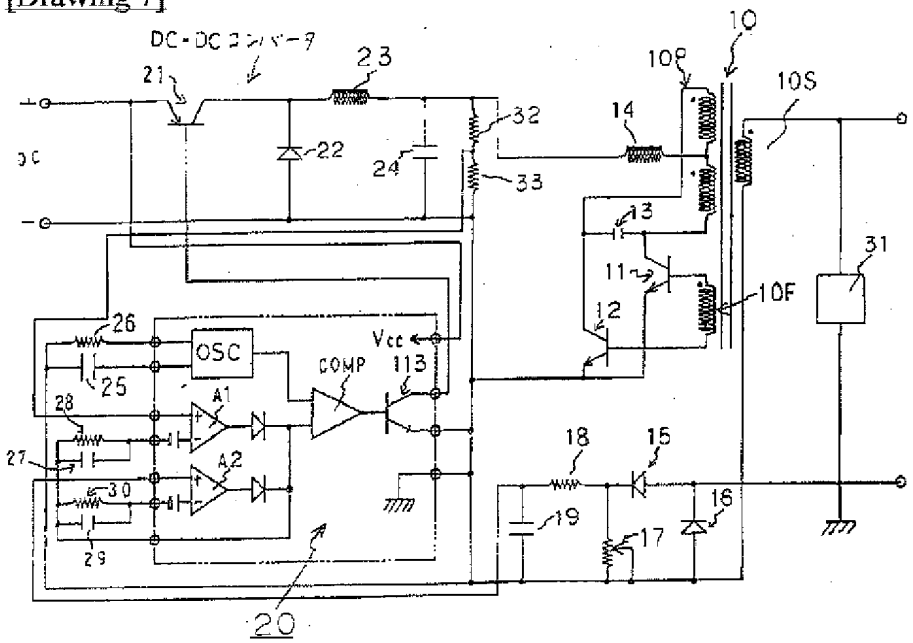
[Drawing 5]



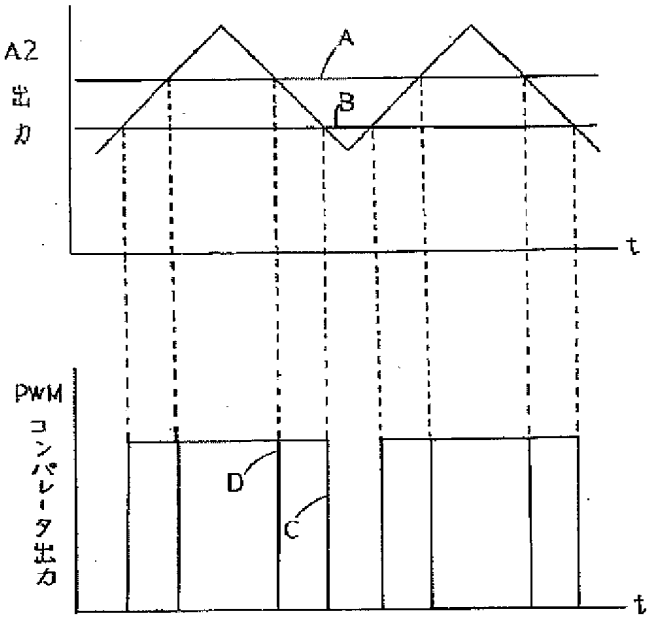
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]